comprises an XY separation drive mechanism,

the XY separation drive mechanism comprises a first hinge member attached to the cylinder head, a rocker arm pivotably attached to this first hinge member, a Y-axis separation slider coupled with the suction valve and supported by the first hinge member reciprocatively in the third direction, an X-axis separation slider supported pivotably by one end of the rocker arm and coupled with the Y-axis separation slider reciprocatively in a direction perpendicularly intersecting the third direction and a cam contacting another end of the rocker arm to swing the rocker arm.

According to another embodiment of the invention, there is provided an air refrigerating device comprising: a compressor which pressurizes and cools air; an expander of the above embodiment which takes in pressurized air discharged from the compressor and cools and discharges the pressurized air.

Brief Description of Drawings

FIG. 1 is a block diagram schematically showing an air refrigeration device including an expander according to the first embodiment.

FIG. 2 is a perspective view showing an appearance of the expander.

FIG. 3 is a perspective view showing a back side of the expander.

FIG. 4 is a perspective view of the expander, showing an internal structure thereof.

FIG. 5 is a front view of the expander.

FIG. 6 is a perspective view showing a crankshaft of an XY-separation crank mechanism in the expander.

FIG. 7 is a plan view of the crankshaft.

FIG. 8 is an exploded perspective view showing the crankshaft and a crank connection plate.

FIG. 9 is a partially cutaway side view of a valve mechanism of the expander.

FIG. 10 is a perspective view showing an XY-

separation valve mechanism.

FIG. 11 is a block diagram schematically showing an air refrigeration device according to the second embodiment.

FIG. 12 is a perspective view showing the refrigerator of the air refrigeration device according to the second embodiment.

FIG. 13 is a side view of the refrigerator.

FIG. 14 is a side view of the refrigerator with a cover being opened.

FIG. 15 is a side view schematically showing an air refrigeration device according to the third embodiment.

Mode for Carrying Out the Invention

Hereafter, an example of an expander including a Z-mechanism XY-separation crank according to an embodiment and an air refrigeration device including

CLAIMS

1. An expander comprising:

a piston provided reciprocatively in a first direction in a cylinder;

a crankshaft extending to intersects perpendicularly a reference plane including a moving axis in the first direction of the piston;

an XY-separation crank mechanism provided between the piston and the crankshaft, which converts a reciprocating motion of the piston and a rotary motion of the crankshaft into one another, the XY-separation crank mechanism comprising a support member reciprocative in the first direction, and a crank connection member provided reciprocatively on the support member in a second direction perpendicular to the first direction, to which a crank of the crankshaft is rotatably engaged, and a coupling member which couples the piston and the support member so as to reciprocate together with the piston and the support member in the first direction,

a cylinder head provided on the cylinder to define a first expansion/compression chamber between the cylinder head and the piston, and including an inlet port and an outlet port which communicate to the first expansion/compression chamber;

a suction valve supported reciprocatively by the cylinder head in a third direction, which opens/closes the inlet port;

a discharge valve supported reciprocatively by the cylinder head in a fourth direction, which opens/closes the outlet port;

an inlet-side valve mechanism which opens/closes the suction valve; and

an outlet-side valve mechanism which opens/closes the discharge valve,

wherein

at least one of the inlet-side valve mechanism and the outlet-side valve mechanism comprises an XY separation drive mechanism,

the XY separation drive mechanism comprises a first hinge member attached to the cylinder head, a rocker arm pivotably attached to this first hinge member, a Y-axis separation slider coupled with the suction valve and supported by the first hinge member reciprocatively in the third direction, an X-axis separation slider supported pivotably by one end of the rocker arm and coupled with the Y-axis separation slider reciprocatively in a direction perpendicularly intersecting the third direction and a cam contacting another end of the rocker arm to swing the rocker arm.

2. The expander of Claim 1, wherein
the support member comprises a first support part prolonged in the first direction, and a second support part prolonged in the second direction from the first support part, and is formed in the shape of an L character, and the first support part is supported by a first slider slidable in the first direction.

3. The expander of Claim 2, wherein
the crank connection member is attached to a second slider slidable in the second direction, and the crank part of the crankshaft is rotatably supported by the crank connection member.

4. The expander of any one of Claims 1 to 3, wherein
the cylinder includes a partition opposing the cylinder head with a gap therebetween, and defining a second expansion/compression chamber between the partition and the piston, and a second inlet and a second outlet which communicate to the second expansion/compression chamber, and

which further comprises:

a second inlet-side valve mechanism including a second suction valve

which opens/closes the second inlet; and

a second outlet-side valve mechanism including a second discharge valve which opens/closes the second outlet.

5. The expander of Claim 4, wherein
the coupling member which couples the piston and the support member with each other extends to be airtightly put through the partition.

6. The expander of Claim 4, wherein
at least one of the second inlet-side valve mechanism and the second outlet-side valve mechanism comprises an XY-separation drive mechanism.

7. An air refrigerating device comprising:

a compressor which pressurizes and cools air;
an expander of any one of Claims 1 to 6, which takes in pressurized air discharged from the compressor and cools and discharges the pressurized air.

8. The air refrigerating device of Claim 7, further comprising a refrigerating unit which applies the cold air discharged from the expander to an item to be frozen, and freezes the item.

9. The air refrigerating device of Claim 8, wherein
the refrigerating unit comprises a cooling covering provided to cover the item to be frozen, and an air-pipe which guides the cooling air discharged from the expander into the cooling cover.

10. The air refrigerating device of Claim 9, wherein
the cooling cover is pivotally supported between a cooling position where the item to be frozen is covered and an open position where the item is

uncovered.

11. The air refrigerating device of Claim 7, further comprising a power generator, an engine, a first clutch which connects the expander and the power generator together, a second clutch which connects the engine and the power generator and a third clutch which connects the compressor and the engine.